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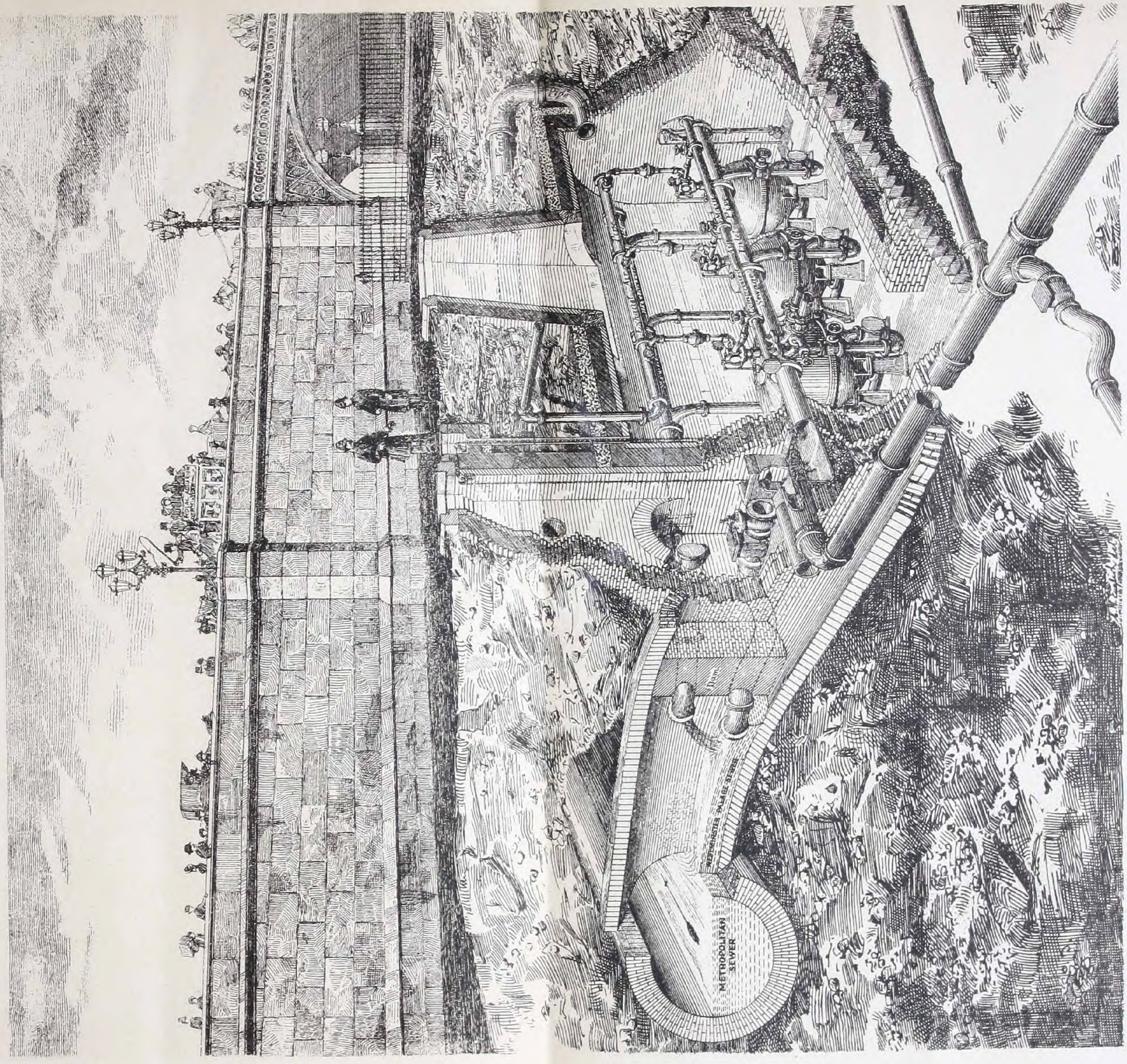
THE SHONE
HYDRO - PNEUMATIC SYSTEM
OF
SEWERAGE.

BY
URBAN H. BROUGHTON, Assoc. M. Inst. C. E.

APRIL, 1887.

HOUSES OF PARLIAMENT WESTMINSTER.
— DRAINAGE & VENTILATION WORKS —
— SHONE HYDRO-PNEUMATIC SYSTEM —

(Engineers) ISAAC SHONE & CO. WESTMINSTER (Gloucester, S.W.)





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THE advantages derived from a perfect system of sewerage are so manifest that it is unnecessary to enlarge upon them, "*salus populi suprema lex.*" It therefore behoves all municipal and other authorities, about to execute sewerage works, to fully inquire as to whether those works, when executed, will prove sanitary or unsanitary. If the latter, they cannot fail to seriously affect the physical health, and consequently the moral well being and material prosperity of the community.

Referring to the water-carried sewerage system, which is generally admitted to be the only practical method for large cities, Professor Huxley, F. R. S., in an address delivered at the Society of Arts a few years ago, stated: "Disagreeable and imperfect as the old cesspool system was, it was attended with very little danger as compared with that which waits upon the modern water-sewage system, if this system is imperfect. If it is perfect, then it is very perfect; and in fact it is the only possible system in great cities at the present day. It has, however, this terrible peculiarity, that if it is imperfect, it becomes the most admirable machinery for distributing the death and disease which may be found in one locality, as widely as possible into others, and into the very houses of the people. That I believe to be as absolutely true a statement as any to be found in the records of science of the present day, and it therefore becomes a question, how are we to see that this water-sewage apparatus is what I may call reasonably perfect? Of course, no human arrangements are really perfect. There must be an element of chance introduced into all our arrangements, but it is within our power that the element of chance is kept within reasonable bounds."

By the Shone system a reasonably perfect system of sewerage is obtained, because by it engineers can invariably work by rule, and it is

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therefore worthy of full consideration at the hands of sanitary engineers and others.

Whatever differences of opinion may in time past have been entertained, as to the advisability of a duplicate system of sewers, one for rainfall, and the other for sewage, the advocates for the combined system are now in a minority, and though adaptable to both the "combined" and the "separate" systems, it is to the "separate" system that the Shone system can be most advantageously applied in its entirety. This system has now been applied to several large towns and districts (referred to hereafter) in England and abroad, and the results have amply justified the inventor's claims, both as to the scientific principles upon which it is based, its efficiency, and the economy of first and annual charges. In the early part of last year a select committee of the House of Commons, presided over by Sir Henry Roscoe, F. R. S., was appointed to inquire into the ventilation and drainage of the House, and the result of the investigations of the committee, led to the Shone System of Sewerage being applied to the British Imperial Houses of Parliament. This cannot but be considered as a national acknowledgment of the superiority of the Shone system.

The great *desiderata* in a system of sewerage are that—

1st. It should remove effectually, and rapidly, the sewage from the inhabited area to some given point.

2d. The sewage should be removed at the velocity requisite to cleanse the channels.

3d. It should be applicable to any area, whatever the natural configuration may be.

4th. If the sewage is delivered upon land, it should be delivered fresh before it has lost its chief manurial properties.

5th. If the sewage is discharged into the sea, or river, the discharge should take place at all times, regardless of the state of the tide.

6th. The cost of construction and annual maintenance should not be excessive.

7th. It should be capable of being extended, as a town grows, without altering any work already constructed.

It is the writer's object to show how the Shone system complies with these *desiderata*; but before entering into details, he cannot do better than give here a brief description of the principle of the Shone system in the words of Mr. W. Donaldson, M. A., Mem. Inst. C. E., who was Engineer in charge of the Reading sewerage and sewage-farm works, which are now regarded as a sanitary and financial success.

"By the adoption of this principle, good gradients can always be obtained, whatever may be the natural configuration of the surface of the inhabited area. Only small self-cleansing stoneware pipes are therefore required, which cost very little, and in a sanitary point of view are by far the best.

"This result can only be obtained by the adoption of several collecting stations, at which the sewage can be raised from a lower to a higher level. With the ordinary appliances for pumping, this system would be impracticable. The first cost of construction of buildings and machinery would be very great, and also the subsequent annual working expenses, because the cost of labor and several other items would be the same at each station, and the cost of fuel much more than if all the power required was brought into use at one place. By the invention of the 'Shone Hydro-pneumatic System' and 'ejectors,' this difficulty can be overcome. The ejector is an apparatus for raising liquid by means of compressed air, which can be conveyed in pipes to almost any distance without sensible loss of pressure, if mains of a proper size are adopted. Compared with mains for the conveyance of water, the mains required for the conveyance of an equal bulk of compressed air, in the same time, are very small, because the loss of pressure due to friction is, in the case of air, *cæteris paribus*, only about *one-thirtieth* at the most of the loss due to the same cause in the case of water.

"In the case of ordinary pumping apparatus a great difficulty is always experienced in securing sites for the erection of the machinery. The machinery itself occupies a considerable space, and tanks of large capacity are required, because the rate of pumping is uniform, whilst the rate of flow of the sewage is variable.

"The ejector stations will be all underground, and may be erected in the public thoroughfares, without interfering in any way with the street traffic. Unless, therefore, special reasons exist for the erection of stations on private property, no expense need be incurred in procuring sites. No collecting-tanks are required, because the rate of working of the ejectors will vary with the rate of supply of the sewage. A sufficient number of the ejectors must be provided at each station to deal as fast as it comes, with the maximum quantity. When the flow of sewage diminishes, the rate of working will diminish. By a very simple automatic arrangement of the machinery for producing compressed air, the rate of production of compressed air varies with the quantity required by the ejectors."

It is generally admitted by sanitary engineers, and therefore may be looked upon as an axiom, that the velocity at which sewage should be made to flow through house-drains, should never be less than three feet

per second, and in public sewers, when the greatest quantity of sewage is flowing through them by gravitation, the velocity should never be less than from 2 to $2\frac{1}{2}$ feet per second. If provision is made for obtaining these velocities, the sewers become self-cleansing sanitary sewers; if not, they will soon become sewers of deposit, and resemble more or less elongated cesspools, the noxious and death-bearing gases from which are exuded into the atmosphere, through manholes, gratings, and ventilators. It is therefore of paramount importance that sewers should be laid at gradients which will cause them to be self-cleansing, and consequently sanitary ones. Why, then, is this not done? The answer is, that in the majority of cases, from the natural configuration of the area, it is not practical to do so when the system of gravitation is employed, as will be explained in detail.

Some areas are favorably configured for gravitation sewers, and in these cases artificial means for the propulsion of sewage are unnecessary; but in the majority of cases, the natural configuration is such, that to collect and convey the sewage sanitarily to one point, there to be raised or discharged, as the case may be, is practically impossible, because, in order to lay the pipes at gradients in accordance with hydraulic rules, so as to give the requisite velocity to make them self-cleansing, they would have to be laid at a great depth, involving a cost which would preclude their being so laid. Engineers, therefore, in designing works on the old gravitation system, are compelled, by the nature of the system itself, to ignore hydraulic rules, and put in sewers which cannot be sanitary sewage-carriers. Artificial flushing arrangements, superadded to an extensive system of non-self-cleansing sewers, will not avail the engineer in producing a sanitary sewerage system, and maintaining it permanently as such.

Now, upon the Shone system the area under treatment is divided into as many natural drainage areas as is desirable, and the sewage from each conveyed in small pipes laid at proper gradients to the lowest point. Here there is an ejector station, and the sewage, as fast as it flows into and fills an ejector, is raised automatically by compressed air, into a sealed iron main, and conveyed under pressure to the outfall, and it is therefore impossible that the sewage can ever remain long enough in the sewer to decompose and give off noxious gases. Moreover, however long it may remain in the sealed pipe, it will not decompose, because it is cut off from the decomposing agent—the air. The sealed iron main can be laid, like water-pipes, a few feet only under the surface of the ground, whatever the natural configuration may be, inasmuch as sufficient pressure is always provided to deliver the sewage at the outfall in a rapid manner,

and once in the sealed main it can have no communication with the atmosphere except at the outfall.

Quite as important as the gradient of a sewer, is that it should be proportioned to the volume that it has to deal with. Large sewers, provided they are properly charged with sewage, can be laid at comparatively flat gradients; on the other hand, small sewers must be laid at comparatively steep gradients, but even at these gradients they must be properly charged, as the maximum velocity is obtained when a pipe is running about three-fourths full, which is a little in excess of that when running one-half full, or full. In the two latter cases it is the same.

One great blot on the "combined" system is, that sewers must be designed to carry the maximum amount of sewage, subsoil-water, and rainfall, that can possibly occur. Now as this maximum amount occurs but seldom, at other periods there is not sufficient volume flowing through them, even supposing they are laid at proper gradients, to render them self-cleansing, and therefore they may be considered during normal periods to be most unsatisfactory.

The primary essentials of good drainage necessary to make sewers sanitary ones are: (1) Gradients laid in accordance with hydraulic rules; (2) sewers proportioned to the volume they have to carry; and (3) a certain volume to flow over a proper gradient. And here the writer would point out the difficulties which beset an engineer, in designing a system of ordinary gravitation sewers in an unfavorable area. He can exercise his skill in obtaining the best gradients possible, and he can calculate the sizes necessary to convey the assigned volume of sewage, but his skill will not give him control over the velocity. If the gradients are flat, the sewers become cesspools, and breeders of sewer-gas. The control over the gradients can therefore only be obtained by making the network of sewers converge to the natural drainage point, instead of to one outfall only. On the ordinary system, this would mean several independent pumping-stations, with separate staff to each station, instead of merely an automatic ejector, worked (together with all other ejector stations) from one air-compressing station, which may be any distance away.

In the Shone system the length of sewers leading to each ejector station is short, so that the sewage is delivered quite fresh, and in such condition passed into the sealed iron main, and delivered at the outfall, when, if it is to be used for manurial purposes, it has a much greater value than if delivered in a stale or half-decomposed state; and to insure the small main-sewers supplying the pneumatic ejectors with sewage being swept clean, as it were, twice a day, automatic flush-tanks (on the same principle as the House Sewage Ejector, described hereafter)

supplied with clean water, are to be placed, where necessary, at the head of the small properly-laid main sewers converging at the ejector stations. All the gravitation sewers leading sewage into the ejectors would be effectively ventilated, but being always free from foul sewage the air-currents flowing through them would be harmless and innocuous.

Again, by the ordinary system, pumping goes on at a uniform rate during a certain portion of the 24 hours, but as the rate of flow of sewage is variable, storage must be provided equivalent to certainly more than one-fourth of the whole day's flow. Not unfrequently the sewers themselves are designed to act as storage-reservoirs, with the inevitable effect of generating sewer-gas. The rate of working the ejectors varies with the rate of flow of the sewage, so to prevent waste of power, governors and reducing-valves are frequently used to stop the steam-supply to the compressors, when the pressure required to raise the sewage has been obtained. The compressors, therefore, as well the ejectors work automatically.

In the Shone system the air-mains and air-receivers, filled with pure air, discharge the same functions as storage-reservoirs filled with foul, decomposing sewage. In the case of the storage of air, unsanitary conditions are avoided, whereas in the case of the storage of sewage, unsanitary conditions are assisted. If a city adopts the Shone system in its entirety, it does not require larger than 7-inch gravitation collecting sewers, and these should be laid at a gradient of 1 in 200. The excavations required will be small. Rainfall or subsoil (if needed) pipes can be laid in the same trench, when convenient, as also can the sealed iron main and air-pipes. When circumstances will permit, an ordinary gravitation sewer may take the place of the sealed iron main.

In sewerage a city in the ordinary method, the probable future increase in population must be taken into consideration, in designing main sewers, but in the Shone system it is not necessary, in the same way, to take the future growth of a city into consideration, as any increase in the population can be provided for when it arises, by putting down additional ejectors as they are required.

With reference to house-drains, notwithstanding their large capacities to discharge sewage, if they do not exceed 4 to 6 inches in diameter, and if they are laid at the gradient suitable for them, it is found that they perform their functions tolerably successfully; but when the house-drain is very long, even though it should be laid at the gradient suitable to its size, which is rarely the case in flat or low-lying places, the plan of letting the sewage into it in ever-varying dribblets cannot fail, sooner or later, to render it foul and objectionable. The

only way to overcome this difficulty, is to cause the whole sewage discharges of the house, as these accumulate, to pass quickly through short and properly graded drains, into a receptacle, which shall hold them temporarily and harmlessly when they are fresh, until they attain a volume, which, when suddenly released, will have the effect of charging the main drain of the house, more or less full bore, throughout the whole or the greater part of its length.

Mr. Shone has designed such an apparatus. This, which is called a "House-Sewage Ejector," will receive anything in the shape of sewage proper, and permit what it receives to pass out of it freely. It is perfectly automatic in its action. The tributary house-drains are made to converge to it, instead of converging, for instance, to a cesspool. The apparatus, Fig. 1, is so shaped that whether it be empty or full it always forms a deep fresh sewage water-seal or trap, to prevent any sewer-gas, which might be formed in the public sewer, into which its contents are automatically discharged, from passing through it into any of the tributary house-drains. The apparatus is well ventilated, it is self-cleansing, and would discharge ten times a day, at a household yielding 300 gallons per day, into the sewage system of a city.

The sanitary collection and propulsion of all domestic waste-fluids can be relied upon by aid of this apparatus.

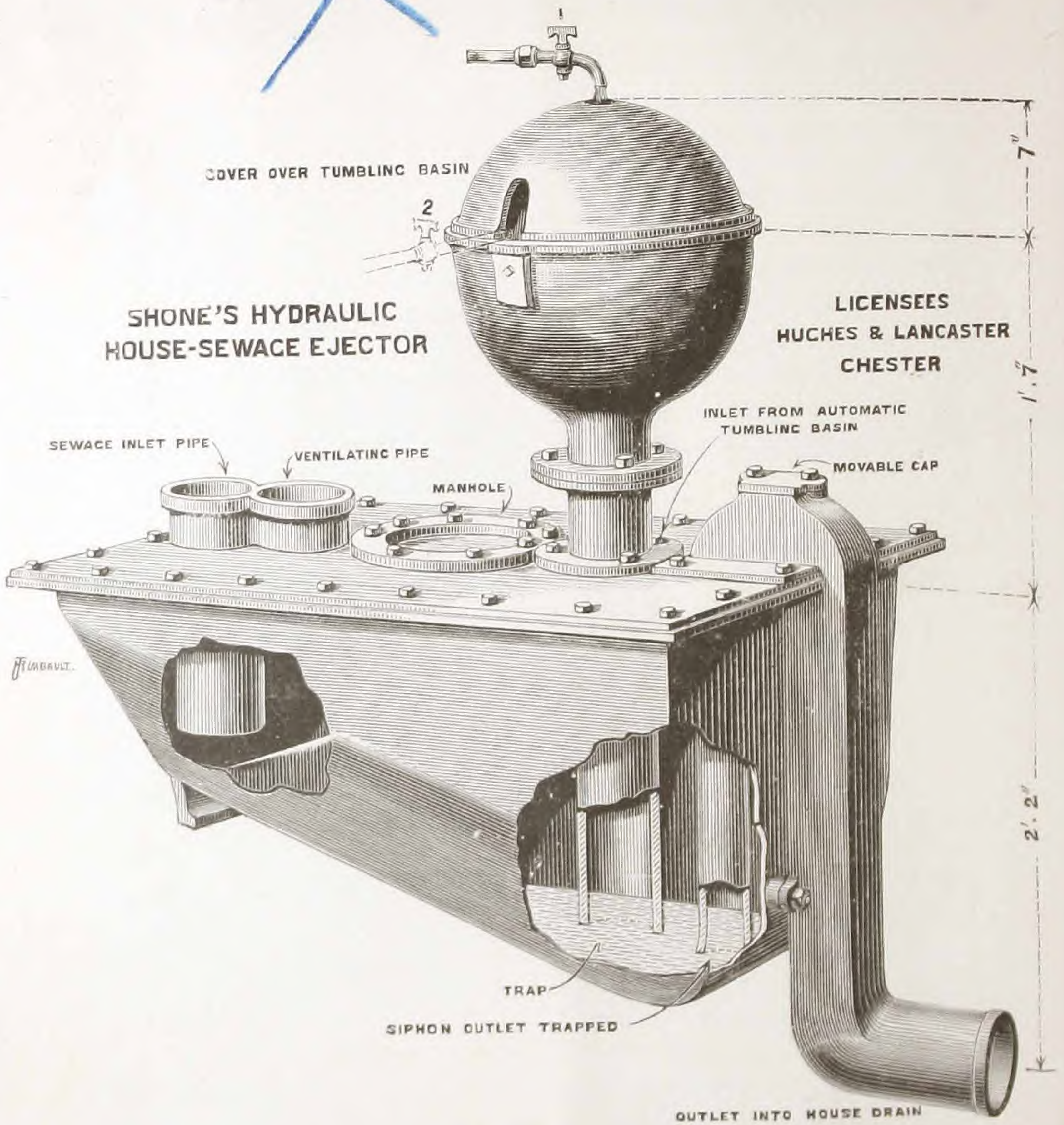
The mechanical appliances required in connection with the complete application of the Shone system consist of :

1st. "Hydraulic Sewage-Ejectors" fixed at the house. "Hydraulic Flushing Ejectors" fixed at the head of the 7-inch gravitation sewers.

2d. "Pneumatic Sewage-Ejectors" fixed at as many stations within the area, district, or city to be drained, as may be desirable.

3d. Steam-engines and boilers, where water-power is unavailable, air-compressors and air-receivers ; these latter are fixed at one station, from which air-mains are connected to the various pneumatic ejector stations. The hydraulic and pneumatic ejectors are made of cast iron, of any capacity or shape.

Figure 2 is a drawing of a pneumatic sewage ejector, showing how it receives the sewage through the inlet-pipe, and how it ejects it again through the outlet-pipe, into what is called a sealed iron sewage main. These ejectors are, by preference, put in duplicate, at each pneumatic station. The gravitation sewers carry the sewage to the inlet-pipe, down which it flows into and fills the ejector. On this inlet-pipe there is a



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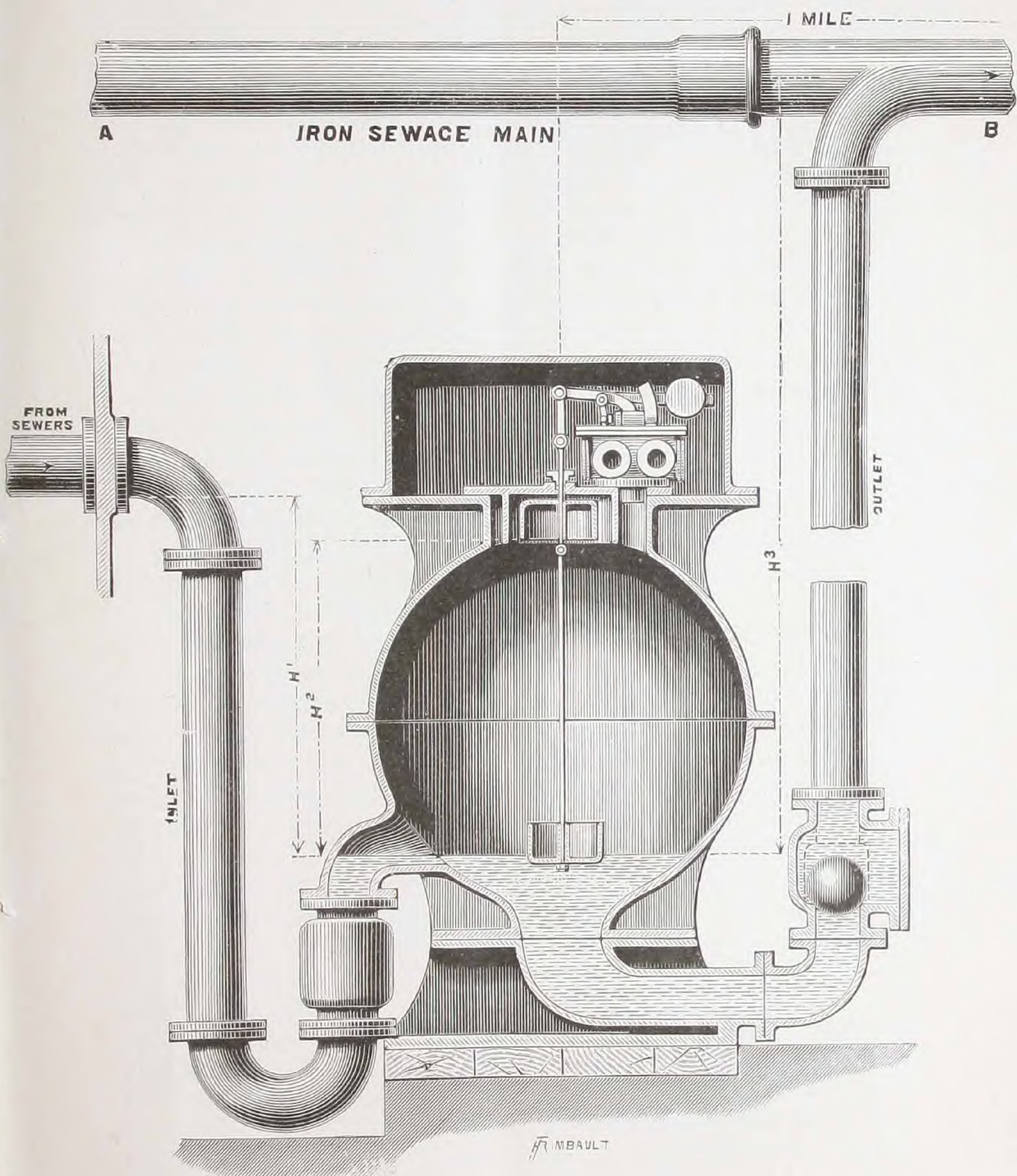


FIGURE 2.

lignum vitæ ball-valve, which, by the inflowing action of the sewage, is lifted off its seat, and thereby permits the sewage to enter the ejector. There is a corresponding valve of the same material and make on the outlet-pipe. When the ejector is full the compressed air is automatically admitted into it, and that same instant the sewage in the ejector tries to escape back to the gravitation sewers whence it came ; but the ball-valve on the inlet-pipe falls on its seat to prevent it. The sewage, therefore, can only escape from the ejector *via* the outlet pipe, which it does by lifting and consequently passing the ball-valve on that pipe. When the whole charge of the ejector has thus escaped, the automatic gear, which is extremely simple and strong, is instantly set in motion, and the result is that the compressed air rushing into and ejecting the sewage, is stopped from entering the ejector any longer, and simultaneously the exhaust port of the automatic cylinder is opened to permit the compressed air, that had ejected the first charge of sewage out of the ejector, to escape into the atmosphere direct, or into the gravitation sewers to aid in their ventilation. This is of advantage, as it has been shown by Professor Tyndall that compressed air destroys organic germs. The moment this happens, the ejected sewage in the outlet-pipe tries, as it were, to get back into the ejector, but it is prevented from doing so by the ball-valve inserted in it. The sewage in the inlet-pipe, however, the moment the pressure within the ejector is reduced below the pressure which is due to a column of water, corresponding to the drop there is between the surface of the sewage at the top of the inlet-pipe, and the surface of the sewage within the ejector (when this latter has been emptied of its charge) begins to descend and to rush into the ejector, past the inlet ball-valve, at such a velocity as will insure the seat of the valve and its chamber being kept in a self-cleansing condition. The sewage will continue to flow down the inlet-pipe, as fast as it finds its way to the pneumatic ejector stations, until the ejector is filled, when the inflowing action will be arrested as before, to permit of the ejector being again emptied ; and so the operation of filling and emptying will go on from minute to minute, and from hour to hour, until the day's work is done.

The illustration shows how these ejectors are connected with the gravitation sewers which fill them, and it also shows how they are coupled up to a sealed iron sewage main. Any number of ejectors may be coupled up in this way to one sewage main common to all, however near to, or distant from, each other they may be. As the quantity of sewage ejected increases at each station, so will the diameter of the sewage main be increased accordingly. But this sewage main will convey the sewage out of the city, to any desired point of outfall, on the

same principle that the water-supplies are brought into the city—that is, under pressure; and what is most important of all, the sewage so conveyed, like the potable water so conveyed, will not offend the olfactory organs of the public who walk over them. Once the sewage is ejected into this sewage main, it cannot escape therefrom, neither can the decomposing agent, the atmosphere, get at it till it reaches the outlet end of it. But as the sewage reaches the pneumatic ejector when it is fresh and harmless, it follows that it must arrive at the outlet in that condition, however far distant it may be from the various ejector stations.

These sewage-receiving and sewage-discharging ejectors, distributed about the city, in the manner described above, are connected by means of small iron air-pipes with the air-compressing station, very much in the same way as the gaseliers in our houses are connected with the gas-works.

The ejectors, too, work noiselessly out of sight, as they are fixed in a small manhole-like chamber under the street, and being thus placed their sites will cost nothing to the municipality.

The power of the engines and boilers, of course, depends upon the density to which the air has to be compressed in each case. A few examples are given in the following table (see page 14) of the engines, boilers, and air-compressors, etc., employed on executed works.

Gas-engines can be advantageously employed for compressing air, when the volume of sewage, and the height to which it has to be lifted, is not great. Atkinson's differential 4-horse-power gas-engines are used at the Houses of Parliament.

The air-compressing station may be erected in a city, on any site which can be bought cheaply, or which, for other reasons, may be considered the most suitable for the purpose. Compressed air, unlike water, does not consume great power in transmission. On the contrary, the power absorbed in its transmission to great distances, so long as the velocity is not excessive, is known to be inappreciable. In practice it is found best to adjust the sizes of the pipes to admit the compressed air travelling at the velocity of twenty feet per second.

The power of compressed air has long since been known, but it is only of late years that its application has been extensive. At first the engines used for compressing it were of the rudest type, resulting in giving the power a bad name, on account of the expense attending its compression and utilization. Now, however, the science and practice connected with the production and utilization of compressed air as a motive power are well known. The writer would point out that the

Place.	Type of Engine.	Cylinders.	Stroke.	Indicated Horse-power of Engines.	Type of Compressors.	Cylinders.	Stroke.	Density to which Air is Compressed.		Quantity of Sewage per Minute, per Gallons.	Maximum Lift, including Head due to Friction.	No. of Ejector-Stations.	Air-Receiver.	
								Ordinary Working Pressure. Lbs.	Maximum Pressure Obtainable. Lbs.				Number.	Dimensions.
Eastbourne.	Horizontal high-pressure.	10 1/2"	1' 11 7/8"	15	Sturgeon's trunk.	14 1/16"	1' 11 7/8"	15	40	1250	22 feet	3	4	18 feet long, 6 feet diameter.
Henley.	Compound condensing high and low pressure.	High-pressure, 11" Low-pressure, 19"	18"	30	Shone & Ault's Improved trunk.	14"	1' 9"	35	70	225	180 feet in two lifts of 90 feet	4 Collecting Intermediate.	1	27 feet long, 6 feet diameter.
Houses of Parliament.	Atkinson's differential gas-engines.	8 1/2"	15"	4 (actual.)	Atkinson's.	8 1/2"	12"	8	12	1200	25 ft.	1	3	15 feet long, 4 feet 3 inches diameter.
Southampton.	Horizontal non-expanding non-condensing.	9"	18"	25	Shone & Ault's Improved trunk.	14"	18"	12	60	1300	25 ft.	3	2	(1) 12 feet long, 4 feet diameter. (2) 20 ft. 3 in. long, 5 feet diameter.
West London District Schools.	Horizontal non-expanding non-condensing.	8"	8"	5	Walker's.	8"	8"	12	20	100	25 ft.	1	1	12 feet long, 4 feet diameter.

way in which compressed-air power is utilized on the Shone system, enables its users to get the highest possible efficiency out of it.

On the Shone system, the air, before it does the work of which it is capable, does not actuate an executive engine, thereby losing the air and power necessary to actuate such executive engine or pump, which varies from twenty-five to fifty per cent., according to the size and make of the executive engine, but it is wholly employed in doing the work required of it. Instead of pushing the piston of an executive engine or pump backwards and forwards, when it is admitted into the ejectors, it pushes the sewage itself out. The sewage in the ejector thus becomes a piston, which is driven downwards by pneumatic pressure out of the ejector. When the full charge of sewage has been ejected, the charge of compressed air, which has ejected it, escapes into the atmosphere or into the sewers, through the exhaust ports of the automatic gear.

The total percentage of the volume of compressed air which is lost in actuating the automatic gear, connected with the ejector, and which is lost in clearance and otherwise, is a mere bagatelle, and need never exceed, in ejectors of 200 gallons capacity and upwards, one per cent. The compressed air being applied direct on to the surface of the fluid, its whole power is thus exerted, and that without any appreciable loss from friction due to the expulsive action of the ejector itself. The degree of economy realizable by the use of the ejectors increases as the number of stations at which it is desired to pump increase, because it matters not how numerous and widely apart the ejectors may be, they can be operated from one air-compressing station with the same facility and economy practically, and with the same unerring certainty of automatic action, as if there was only one ejector-station, and that close to the air-compressing plant.

Besides being able upon the Shone system, to eject sewage up to a lift of, say, fifty feet, at one pumping-station, as economically as if a really satisfactorily economical pump was employed to do the same amount of work; as already intimated, sewage can also be ejected at ever so many different pumping points, however far or distant they may be from one another. The bulk of the sewage would this way be diverted to the outfall, at comparatively short lifts, instead of the whole gravitating down to the lowest point, and there raised the maximum lift. In order to carry out this division of districts, the lifts might possibly be unequal, and in such cases reducing-valves would be employed to lower the pressures required for the low lifts.

When it becomes desirable to raise the sewage from the lowest to the highest level at one lift, it will be necessary to compress the air in

the first instance, to the maximum density required for the highest lift, and allow it to expand again to the volume corresponding to the pressure due to the next lift, and so on, as suggested above. The best plan, however, is to try to divide the maximum lift into a number of as nearly as possible equal stages, say of fifty or sixty feet lifts, and to compress the air to the density required for one lift, the sewage being ejected successively through the several stages. At first sight this might appear to involve a loss of economy, but it is not so, as in point of fact there is a considerable gain in dividing up the lifts in the manner indicated.

To provide uniformity of working, air-receivers are employed, the air being compressed to a slightly greater pressure than is necessary to raise the sewage, but in some cases the mains themselves afford quite enough storage capacity.

The air-compressors, as well as engines and boilers, are always provided in duplicate.

The writer may here add that the corporation of Birmingham (one of England's chief manufacturing towns) has approved of, and Parliament has sanctioned the formation of, a compressed-air motive-power company for supplying compressed air to users of steam in Birmingham. At the first installation it is proposed to supply compressed air enough to work engines, which will indicate, in the aggregate 5,000 horsepower. This project has been thoroughly investigated by eminent and competent engineers, and the result of their investigations prove that the present steam-users in Birmingham, will effect a great saving by using the compressed air, supplied at rates, which will insure a handsome financial success to the company.

Competent engineers have designated the Shone system "the system of the future." At present it is in its infancy, but already it is in operation at eighteen different towns and districts in the United Kingdom and abroad, in each of which it has given entire satisfaction. The schemes that have been submitted, and approved of, by the sanitary authorities in the United Kingdom and abroad, and which have been adopted, and wholly or partially executed, will involve when completed an expenditure of nearly half a million pounds sterling.

In addition to towns like Henley and Beaumaris, which have adopted the system in its entirety, the writer desires to point out how it may be advantageously applied as an auxiliary to the ordinary gravitation system of city drainage.

At Eastbourne "ejectors" are employed to drive out to sea, at the highest possible state of the tide, the sewage of a population fluctuating

between 26,000 and 80,000, so that the sewers throughout the towns are kept free from any accumulation or impounding of the sewage, which under the old gravitation system was the case, where any portion of the sewers were tide-locked. The authorities at this important watering place, were so satisfied with the working of the ejectors at the main station, that they put a second station, two miles distant from the first, in, the now, most fashionable quarter of the town, in a spot that had remained unbuilt upon because of the difficulty of drainage by the ordinary methods. Recently they have put down a third station, in another part of the town, $1\frac{1}{2}$ miles distant from the air-compressing station, and the whole of the ejectors are worked from a single compressing station with equal facility.

At Warrington, the system is applied to a low-lying portion of the town to lift the sewage into the existing gravitation sewers. The corporation subsequently put down other ejectors, for the removal of 'excreta' and 'pail contents' from their several depots in the town, to their central works.

Again at Southampton the sewage flows into a reservoir, where it is chemically treated, and ejectors are employed, first to discharge the effluent water into the sea, regardless of the state of the tide, and afterwards the sludge into a depot, where it is further treated with ashes and road sweepings, the compound having a ready sale in the district.

At the Royal Courts of Justice Chambers, London, ejectors are employed to lift the sewage from the crypts into the Metropolitan sewer 27 feet above them. The sewage of the new business premises recently constructed in old Broad Street, London, at a cost of £300,000, is raised by an ejector 20 feet into the Metropolitan sewer. The ejector is placed in the floor of a wine cellar, and supplied with air by a Westinghouse compressor. By this system the value of land in a city is considerably increased, as it enables deep basements to be properly drained. These are a few only of the many ways in which the system can be employed otherwise than in its entirety.

Putting efficiency, which is the true value of sanitary works, aside for a moment, the writer would point out that in places, where it is necessary to raise the sewage collected at one outfall, the machinery necessary to do this (with rising or gravitation outfall) is, as costly as the machinery and sewage main employed in the Shone system, and there can be no question as to the relative cost of small stoneware pipes, laid in shallow trenches, and large and deep sewers, in laying which the amount expended on pumping alone is often very serious.

With regard to annual charges, these have been proved in practice to be less than the maintenance of one sewage-pumping station, together

with staff required to look after the flushing arrangements which large and flat sewers require.

It would not be much criterion to give the actual cost of works executed upon the Shone system, as the value of labor and materials varies so much in different countries. However, for the sake of showing the economy in first cost, and annual charges, of the Shone system as compared with the ordinary gravitation system, the writer gives the following particulars of the cost of the Shone system as executed at a town in England, and also the estimated cost of a gravitation and direct pumping scheme, prepared and estimated for, by an engineer of eminence. It may be added, that, in this as well as two other cases, the Shone system was adopted, after schemes on the gravitation system had been prepared and paid for by the authorities.

Cost of works as executed on the Shone Hydro-Pneumatic System.	Cost of works on the old system as estimated by engineer who prepared the scheme.	Annual working cost on the Shone System.	Estimated annual cost on the old system.	REMARKS.
£14,890	£19,600	£320	£715	These estimates include everything except land. The Shone system lifts the sewage 180 feet and delivers it from 5 separate ejector stations on to land 2 miles from the town. The scheme in the old system was to lift the sewage 40 feet only, and to deliver it on to land close to the town, and therefore on to more valuable land. Owing to the level of the subsoil water throughout the district, and the depths at which the sewers were proposed to be laid on the old system, it may be taken for granted that the work could not have been carried out for the estimated amount.

The following is a summary of the advantages claimed for the Shone Hydro-Pneumatic System of Sewerage, which is patented in Great Britain, America, France, Germany and Italy :

1st. Good and self-cleansing gradients can always be adopted, irrespective of the configuration of the natural surface. *This is of paramount importance at health resorts.*

2d. Impounding of sewage is altogether prevented—decomposition of sewage therefore never takes place—dangerous sewer-gases are not generated, and therefore the objections arising from open ventilators do not arise.

3d. In tide-locked towns, the ejectors force the sewage into either river or sea under every condition of tide.

4th. Small sewers and drain-pipes only are required, whereby the first outlay is considerably reduced, *and the saving thus secured more than compensates for the annual expenses for working the ejectors.*

5th. It is not necessary to take the future growth of any town into consideration, as any increase in population can be provided for, *when it arises, by putting down additional ejectors as they are required.*

6th. Not being tied to any one site for an air-compressing station, it can be erected anywhere, on any cheap site, and from thence the compressed air conveyed miles away (if necessary) in small pipes to the ejectors.

7th. No expenses for ejector sites—as the ejectors can be placed under a roadway—they require no attention, and give off neither smoke nor smell.

8th. The lifting of the sewage at the different ejector stations to any required elevation is effected automatically—no stoker or attendants are required—there is no machinery likely to get out of order—and no consumption of the compressed air, unless the ejector is full and requires emptying.

9th. The advantage of being able, if necessary, to store up the compressed air in receivers, sufficient for many hours' consumption at the ejectors, so that the engines need only work a limited time, and at intervals, to replenish the receivers.

10th. The fact that the "Shone" appliances can play their part in ameliorating and supplementing existing sewerage arrangements, without, in the majority of cases, necessitating a reconstruction of the works, need only to be understood to be appreciated as it is at Eastbourne, Warrington, Southampton, Winchester, and other places.

The writer, as representative in the United States of Messrs. Hughes & Lancaster, the sole licensees in Great Britain and abroad, of the "Shone patents," will be happy to furnish any further information upon being communicated with at the undermentioned address.

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